may turn out to be to some extent accidental, yet the results can hardly be regarded as very far from correct. And in a case of such importance to the maritime engineer where we have so very few direct observations of the waves in the open sea to guide us, and where it is undeniable that all such observations are invariably found to be excessively difficult to get, and even when got prove often unsatisfactory, any contribution to our knowledge, however imperfect, may be considered of some value; and all the more when, as in this case, the curve traced out on the beach is the result of long-continued action produced by innumerable storms.

A RUSSIAN ACCOUNT OF SCIENTIFIC PROGRESS IN INDIA[1]

WE have already noticed the meteorological journey of M. Wojeikoff round the world. The volume referred to below contains a series of letters written to Baron Osten-Sacken and M. Rykatcheff during his stay in India (December, 1875, to February, 1876).

He had great hopes of the development of meteorology in India. A series of stations working upon one uniform plan, together with a system of weather-warnings, was about to be established throughout the country under the superintendance of Mr. Blanford. That gentleman expected a great deal from a thoroughly organised system of weather-forecasts, owing to the periodicity and comparative regularity of meteorological phenomena in India. The non-periodical fluctuations are yet certainly very large—especially as to rains—but they are less complicated than elsewhere, and it was likely to be easier to detect the laws they obey. Already in 1874 the Government asked Mr. Wilson whether it was probable that the rainy period would be as short that year as it was in 1873; Mr. Wilson answered that he expected heavy rains at the end of the monsoons, and October was in fact very rainy. The importance of such forecasts may be seen at a glance, as the rice-crops depend entirely upon the quantity of rains and the time when they finish, the rice-fields giving the best crops when they remain under water during the first two months after the sowing.

A subject treated at greater length by M. Wojeikoff is the Black Earth of India. This fertile soil appears mostly in the western and southern parts of the country, especially on the table-land of the Deccan, whilst on the plains of Bengal and in the north-western provinces it is, on the contrary, nearly wanting. It attains its largest development on traps, being found only as smaller patches on the bottoms of valleys in the districts of crystalline rocks. Altogether, it does not occupy in India such extensive uninterrupted spaces as in Southern Russia, and even in the provinces where it is most developed, it covers but from fifty to seventy per cent. of the surface of the land. The data as to its thickness are few; six feet is not unusual, but thicknesses of twenty feet must have been observed on some deposits washed down from the slopes of the hills. A few analyses show a percentage of from 7·7 to 9·2 of organic matters, not much different from what was found in the black earth of Russia.

As to its origin, the most curious opinions continue to prevail among Indian geologists. Some suppose it to be merely a product of the disaggregation of traps; others continue to support the old opinion as to its origin in marshes. Dr. Oldham, who was the first to renounce an erroneous view long established in Western Europe, in a letter to M. Wojeikoff, adopted the theory of the origin of black earth from "a dense vegetable growth, principally herbaceous, but partly arborescent," although there are localities where it may have come "from jheels and marshes." M. Wojeikoff supports the opinion now prevailing in Russia, that Black Earth is the result of a herbaceous steppe-vegetation accumulated during long centuries. He points out that its marshy origin is contradicted by the facts that, 1, the percentage of organic matter in its upper and lower parts is much the same, while in marshy deposits it constantly decreases in the upper parts; and 2, Black Earth never contains a large amount of acids, as is always the case in marshy deposits. Therefore, Black Earth mostly covers the surface of the lower table-lands, and is of far rarer occurrence in the bottoms of valleys. As to these latter deposits many misconceptions still prevail. Many of them are secondary, being washed down by rains from the tops and slopes of hills, and M. Wojeikoff supposes that the black-earth in the lower parts of the Nerbudda, Taptee, Godavery, Kistna valleys, &c., has mostly such a secondary origin. There are many instances when the black-earth of low levels is not a secondary deposit. It is then the product of a grassy meadow-vegetation, grown upon the former marshy deposit *after* the total draining up of the marsh.

We notice, also, his remarks upon the interest afforded by India for ethnographical and anthropological explorations. There is much to do in these departments. An official report says that not less than two-thirds of the old monuments of India remain unexplored; and there are large parts of the country, as, for instance, the Central Provinces, where almost nothing was done in this direction. The question as to the origin of some of the aborigines of India is still very obscure. The origin of the Dravidians, for instance, seems to be very uncertain, and M. Wojeikoff had much trouble to procure for Dr. Hochstetter some twenty photographs of this interesting people. He warmly recommends India as a field for anthropologists.

[1] *Isvestia* of the Russ. Geogr. Soc., 1876, No. 3.

METEOROLOGY AND THE INDIAN FAMINE

THE following letter appeared in the *Times* of Saturday last:—

In a recent article on the Indian Famine you asked whether science could do nothing to foresee and provide for these appalling calamities. I think that, as regards Madras at any rate, science may safely accept your challenge. The present famine was foreseen on meteorological grounds last year, and the continued drought during the present summer (an unusual feature in Indian famines) was indicated in a printed research as early as February. Meteorologists have for some time been aware that the eleven years' cycle of sun-spots is coincident with a cycle of atmospheric conditions producing ascertained terrestrial effects. Thus the minimum periods of sun-spot activity are coincident with the minimum appearances of the aurora and with the minimum number of cyclones, while the maximum periods of sun-spot activity are contemporaneous with the maximum activity of the aurora and of cyclones. The coincidence between the sun-spot cycles and the variations in the indications of the magnetic needle has also been affirmed, and a periodic connection between solar activity and terrestrial magnetism is now an accepted fact of science. A similar connection between the eleven years' cycle of sun-spots and the temperature and rainfall had also been suspected, and various researches had been undertaken to show that the supposition was well founded. It was at this stage of the inquiry that Dr. W. W. Hunter, the Director-General of Statistics to the Government of India, commenced his investigations last year into the rainfall of Madras. During this century six years of minimum sun-spots had occurred (1810 to 1867); and for practical purposes the present year, 1877, may be taken as the seventh period of minimum sun-spots within this century. Dr. Hunter also found that six great scarcities of sufficient gravity to be officially returned as "famines" had occurred during the same period (1810-77). Of these six famines five were caused by years of drought coincident with, or adjoining to, the periods of minimum sun-

spots, and within Dr. Hunter's "minimum group." He further showed that the rainfall at Madras passed through an eleven years' cycle, corresponding with the cycle of sun-spots. That is to say, the rainfall reaches its minimum in the eleventh year, rises to its maximum about half-way through the cycle in the fifth year, and then declines again to its minimum in the eleventh year. The following condensed table shows the results of the six cycles for which records exist, from 1810 to 1876, the Madras register only having been kept, however, from 1813 :—

Eleven Years' Cycle of Sun-Spots and Rainfall at Madras for Six Cycles, from 1810 *to* 1876.

	Average rainfall in inches, registered at Madras. (1813-76)		Average relative number of sun-spots (Wolf). (1810-60.)
Eleventh series of years in the cycle of eleven years	37·03	...	10·9
First and second series of years in the cycle of eleven years...	42·07	...	10·0
Third and fourth series of years in the cycle of eleven years	49·12	...	39·8
Fifth and sixth series of years in the cycle of eleven years	54·64	...	73·4
Seventh and eighth series of years in the cycle of eleven years ...	52·36	...	53·7
Ninth and tenth series of years in the cycle of eleven years	49·02	...	33·5
Eleventh series of years in the cycle of eleven years	37·03	...	10·9

The general average of rainfall for sixty-four years, from 1813 to 1876, is 48·51 inches.

The average relative number of sunspots, calculated on the fifty-one years then available to Dr. Hunter, from 1810 to 1860, is 38·68.

This statement forms one of a series of eleven tables by which Dr. Hunter exhibited the coincidence of the two cycles. In my opinion, and I believe in the opinion of the other professional meteorologists in this country who have examined the evidence thus submitted, Dr. Hunter has established his conclusions as regards Madras, but he carefully abstains from hasty generalisations with reference to other parts of India. I may add, however, that from a careful examination of the rainfall at Bombay, it is evident that there are the clearest indications of a similar general coincidence, while evidence has recently been adduced of a cyclic character of the Calcutta rainfall, complementary to (although different from) the cycle at Madras. But, adopting Dr. Hunter's cautious estimate of the degree of certitude warranted by his examination (necessarily a partial one) of the Indian rainfall, I think that science may safely make the following replies to your challenge :—

1. That a period of deficient rainfall may be expected to recur in cycles of eleven years at Madras.

2. That the deficiency is of so serious a character that in five out of the seven of these cycles occurring within this century up to the present date, the deficiency has sufficed to cause a great famine in Madras.

3. That the duty imposed by the laws of Nature on the Indian Government is not to make a series of costly spasmodic and unsatisfactory efforts, but to deal with the water-supply in such a way as to meet a regularly recurring deficiency.

4. That the discovery of the cyclic character of the rainfall clearly points, as regards Madras, to the method to be adopted for this end. In the eleven-years' cycle there is a period, at the extremities, of greatly deficient water-supply—namely, in the eleventh, first, and second years of the cycle. There is also a period of excessive water-supply in the middle of the cycle—namely, in the fifth, sixth, seventh, and eighth years ; and half way between these two periods—that is to say, on each side of the maximum central period—there are years of intermediate but ample water-supply—namely, in the third and fourth years on the one side of the central maximum period, and in the ninth and tenth on the other side of it. The following table, taken from Dr. Hunter's paper, very clearly illustrates this :—

	Average rainfall in inches, registered at Madras. (1813-76.)		Average relative number of sun-spots (Wolf). (1810-60.)
Minimum group—eleventh, first, and second years	40·39	...	10·32
Intermediate group—third and fourth with tenth and ninth years	49·07	...	36·71
Maximum group—fifth, sixth, seventh, and eighth years ...	53·50	...	63·61

5. That the permanent remedy for famine in Madras is, therefore, to deal with the rainfall in its cyclic aspect, and to husband and equalise the water-supply, not merely of the individual year, but of the cycle.

It is beyond my province to offer any opinion upon the form of hydraulic engineering best adapted to secure this end. But I would point out that while some of our modern Indian canals are principally useful in husbanding and distributing the water-supply of the year, the old native system of great embanked lakes or reservoirs unconsciously hit the true solution of the difficulty by husbanding and equalising the water-supply of the cycle.

I need hardly say that we are only at the beginning of this inquiry. What science asks from the Indian Government is the means of prosecuting it, and foremost among such means is a small solar observatory, for which it is understood that the necessary instruments were sent out to India some years ago, although they have not yet been utilised for this purpose.

ALEXANDER BUCHAN, Secretary of the Scottish Meteorological Society.

THE IRON AND STEEL INSTITUTE

THIS Association, one of the most active in the kingdom, and which has already done so much to bring the discoveries of science to bear on the iron and steel industries, commences its annual autumn meeting at Newcastle, on Monday, as we have already intimated. As usual, while several important papers are down for reading, much of the time of the meeting, between September 17 and 21, will be devoted to visiting some of the many industrial establishments in and around Newcastle.

The president of the meeting will be Dr. C. W. Siemens, F.R.S., and we notice that in succession to the late Mr. Jones, Mr. James S. Jeans has been appointed general secretary. On the first day the usual formal business will be transacted, the real work of the session commencing on Tuesday, when the Mayor of Newcastle will receive the members in the lecture-room of the Literary and Philosophical Society at half-past 10 A.M., and during the forenoon a selection of papers will be read. After luncheon the remainder of the day will be devoted to visits to various establishments, including Consett Ironworks, the works of Stephenson and Co., R. and W. Hawthorn, Hawks, Crawshay, and Co., the Newcastle Chemical Works, and others. A number of collieries will also be open to the inspection of members, and should a sufficient number be found willing to join in an excursion to the Roman Wall, it is proposed to organise a party, on Tuesday afternoon, to visit that interesting object, near the residence of Mr. John Clayton, the well-known antiquarian, who has kindly promised to receive the members.

The forenoons of Wednesday and Thursday will also be devoted to the reading of papers, and the afternoons to visits and excursions. On Wednesday the New Swing Bridge, one of the largest of its kind in the world, will be opened, and afterwards two steamers will take the